

# NASA TECH BRIEF

## *Goddard Space Flight Center*



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### Irradiation of MOS-FET Devices to Provide Desired Logic Functions

#### The problem:

A common device used in read-only memories is the MOS-FET (metal-oxide semiconductor field-effect transistor). For a given logic function, these devices are arranged in a specific configuration on the surface of a single silicon strip. The development of each configuration is costly, and, once fabricated, the circuit is limited to a single logic function because of fixed thresholds of each MOS.

#### The solution:

Selective irradiation can be effectively used to re-design the MOS logic circuits.

#### How it's done:

This method employs radiation such as gamma, X-rays, electrons, etc. to shift the threshold potentials of selected MOS devices on the logic circuits. Before irradiation, the gates of selected MOS must be biased positive, while gates of devices whose thresholds are not to be shifted are grounded to the substrate. The irradiation is then easily accomplished in a few minutes.

To verify this method, two p-channel MOS devices each having a  $-3.7\text{V}$  threshold were irradiated with a total dose of  $3 \times 10^{12}\text{e/cm}^2$ . One device was biased and the other grounded. As a result of irradiation, the biased device threshold shifted to  $18.7\text{V}$ , while that of the unbiased only shifted to  $5.8\text{V}$ . Thus, if the  $-10\text{V}$  gate potential were applied to both devices, only the latter would turn on, whereas, before irradiation, both would have turned on.

It is estimated that irradiation will maintain the device threshold for ten years. The circuit can be brought back at any time to its original configuration by the thermal annealing of radiation effects.

In the case of n-channel MOS devices, radiation with bias can induce channel conduction even with zero gate voltage.

The obvious advantage of this capability is that MOS circuits designed for a specific logic function can be easily converted to perform a different logic.

#### Notes:

1. Prior to application of this concept the following information is required:
  - (a) The relationship between radiation energy, total dose, and change in threshold voltage.
  - (b) Verification of the necessity for maximum irradiation to the point of saturation to obtain stability.
  - (c) The decay rate versus temperature relationship.
2. Requests for further information may be directed to:  
Technology Utilization Officer  
Goddard Space Flight Center  
Code 207.1  
Greenbelt, Maryland 20771  
Reference: TSP72-10719

#### Patent status:

NASA has decided not to apply for a patent.

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